MAT-91-11

Protocol for the Testing of Surficial Erosion Control Materials

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Abstract: This protocol for the testing of proprietary erosion control products has been developed from test methodologies reported in reports MAT-90-10 and MAT-91-05. The adherence to this testing methodology and to the form of data presentation may be required in order for new surficial erosion control products to be approved for use by Ministry of Transportation to control surficial erosion during highway construction.

Comments: Suppliers of new proprietary surficial erosion control products should direct enquiries to the Supervisor, Roadside Vegetation Management, (416) 235-3654.

Key Words: USLE, Universal Soil Loss Equation, VM, rainwater, mulches, blankets, surficial erosion control

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1/ Background

The Ministry of Transportation (MTO) has developed a methodology for testing new surficial erosion control products. This testing protocol replaces MTO's previous testing methodology which relied on the results of field examination. The procedure supplements other MTO tests concerning the ability of the new product to promote the growth of permanent vegetation, or the evaluation of the practical handling aspects of the product by MTO contractors.

The methodology is based on the Universal Soil Loss Equation (USLE), A = R K LS VM, which gives the annual rate of erosion for specified values of the principal factors affecting surficial erosion on slopes. These factors are: R, the runoff factor, K, the soil erodibility factor, and LS, a combined factor expressing the effects of slope length and slope gradient. The factor VM is a combined factor expressing the effect of the vegetative-mechanical treatments applied on a slope; it is a constant for a particular application, such as a specific rate of mulch with a specific concentration of tackifier. A change in either of these components generates a different VM value.

A more complete description of the definitions and the derivation of the USLE is provided by Clyde et al. (1976), and Wischmeier and Smith (1978).

VM is the ratio of the amount of soil lost from a treated slope to that lost from an identical bare soil slope, under the same rainfall event. Graphically, the value of VM is given from the slope of the line relationship between R K LS (treatment) and R K LS (bare soil) where R K LS (tr) is the rate of erosion on the treatment plot and R K LS (bs) is the rate of erosion on the control plot, both under identical levels of R, K and LS. Since the only variable allowed to change is R, the plot represents the capability of the test material to resist more severe erosion as R is increased. Theoretically, this relationship should take on one of two fundamental forms: a straight line which at some point will begin to ascend where a data point deviates significantly, or an ascending curvilinear shape from the intercept of the ordinate. Where there is a significant departure of data points from a straight line, the initial point of departure represents the point where the test product has begun to break down in effectiveness. This point also represents the maximum rate of erosion that can be controlled with the test application.

In the case where a plot exhibits a curvilinear relationship, the increasing value of the slope indicates that the measure is breaking down progressively in effectiveness as the erosion severity increases. Until VM = 1.00, there is still some erosion control by the measure. When VM exceeds 1.00, more erosion is occuring than on bare soil under the same conditions. In the case of a curvilinear relationship, the

point of maximum erosion control capability is much lower than in those cases where the relationship is a straight line.

A fuller description of the basis for the testing methodology is presented by Armstrong and Wall (1990, 1991).

2/ Testing Method

In the test, a rainulator is used to deliver water to identical test and control plots at a predetermined rate. The size and spatial distribution of individual raindrops simulates natural conditions. The complete runoff, which includes both sediment and water, is aspirated from the collecting mechanism at set times. These samples are then measured, agitated, subsampled, and labelled. In the laboratory, the sediment is filtered from each subsample and weighed.

Separate soil samples are collected at random and in triplicate to be used in the determination of the value of the K factor, the measure of the erosivity of the soil upon which the tests are conducted.

2.1/ Equipment

The following equipment is needed for the testing of materials on slopes, under field conditions.

- A rainulator that delivers rainfall intensities of 17.5 mm/h to in excess of 200 mm/h, using several low to medium flow-rate full jet nozzles in a continuous spray design. With the drop sizes produced, velocities and energy should represent natural rainfall conditions for a given intensity.

- Metal plot delineators will enclose the top and two sides of a 1 m^2 plot. A metal lip and trough, installed on the downslope position will stabilize the soil at the lower boundary and collect runoff. Different plot sizes than are described above are permissible.

- A portable electric pump must be capable of supplying sufficient water under pressure to the plot.

- An aspiration system removes all the water and associated sediment from the collection trough, generated during the two minute period.

- A portable electric generator will supply all required power.
- Sufficient collection, measurement, and sample jars, with lids, corks, and labels, as well as sufficient water storage capacity in the form of barrels and tanks.

Where indoor tilt flumes are used, the equipment can be varied to meet the specifications for the delivery of the simulated rainfall and the minimum plot size, but the testing methodology remains the same.

2.2/ Testing Methodology

The test material must meet all manufacturer's specifications, including composition of the main ingredients and tackifiers. It must also be applied according to manufacturer's recommendations, in terms of rate of application, equipment, and method of fastening. This will ensure that the test application duplicates the descriptions found in the advertising literature. Erosion control materials applied by means of a hydromulcher, or otherwise blown onto the slopes will use the application rate currently specified by MTO.

The slopes to be used for testing should be uniformly 2:1 (2 horizontal:1 vertical), and of uniform soil characteristics, with a soil erosivity (K) factor of at least 0.45 according to the method for the determination of K (Wischmeier, 1978). Three test and three control plots, representative of the soil erosivity, aspect and slope gradient of the main slope, shall be randomly chosen on the selected slope.

All runoff and sediment collected in the trough during a two minute interval is to be aspirated and measured. After this mixture has been completely agitated, a 100 ml sample is to be taken for laboratory analysis and appropriately labelled. A total of 30 samples for each run conducted on each of the test and control plots are to be collected.

3/ Analysis Method

Sediment concentrations in the runoff are to be determined gravimetrically, by filtering the runoff through pre-weighed 0.45 µm filters under vacuum pressures.

Soil samples are to be analyzed for particle size distribution, organic matter content, pH, and calcium carbonate content (McKeague, 1978). Soil moisture content is to be determined gravimetrically. The value of K is to be determined as described by Wischmeier and Smith (1978).

4/ Presentation of Data

A separate report is to be prepared for each erosion control material tested.

4.1/ Tables

For each test and control plot, the data means of the following parameters are to be presented for the end of each two minute time interval: interval sediment concentration (g/L), cumulative sediment concentration (g/L), interval runoff (L), cumulative runoff (L), interval soil loss (g), and cumulative soil loss (g).

4.2/ Figures

The above data are to be presented as graphs showing the relationship of each parameter to the end of each two minute test interval.

A plot of the relationship of the EI values for the rainulator against the end of the two minute simulated rainfall period is to be presented. This will form the base data for further analysis required for MTO to provide approval and categorization of the test product.

In addition, at the end of each two minute testing interval, a plot of the soil loss on the test plot against the same data for the control plot is to be presented. On this plot, an arrow should be used to show the initial point of significant deviation from the preceding straight line relationship of these parameters. The EI value of this point of significant deviation is to be identified in the report.

5/ Submission of Data

Reports in triplicate should be submitted to the Secretary of the New Products Committee, Research and Development Branch, Ministry of Transportation, Downsview, M3M 1J8. They should be submitted in conjunction wth a completed set of the Ministry's New Product Identification Sheets available from MTO, or as a supplement to a previous submission.

5.1/ Additional

The erosion control material being submitted for MTO approval must have the ability to produce a satisfactory stand of permanent vegetation in a short time period. Therefore, the testing of the erosion

control effectiveness of the material should be conducted in conjunction with standard MTO testing procedures on the establishment of permanent vegetation. Additional information can be obtained from the Maintenance Operations Office of MTO.

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